higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T530**(E)**(M27)T

# NATIONAL CERTIFICATE

# ELECTROTECHNICS N4

(8080074)

**27 March 2018 (X-Paper)**
**09:00–12:00**

**Calculators may be used.**

**This question paper consists of 7 pages and a formula sheet of 2 pages.**

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# DEPARTMENT OF HIGHER EDUCATION AND TRAINING
# REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ELECTROTECHNICS N4
TIME: 3 HOURS
MARKS: 100

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**INSTRUCTIONS AND INFORMATION**

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Questions may be answered in any order but subsections of questions must NOT be separated.
5. Write neatly and legibly.

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## QUESTION 1

1.1 Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (1.1.1–1.1.10) in the ANSWER BOOK.

1.1.1 The THREE main parts of an induction motor:

A Rotor, frame and fan
B Frame, stator and rotor
C Stator, rotor and end plates
D Fan, cooling fins and fan cover

1.1.2 Purpose of a capacitor in a single-phase capacitor motor:

A It increases the speed of the motor.
B It causes the motor to operate at a good power factor.
C It protects the motor from overheating.
D It allows the motor to stop automatically in case of emergency.

1.1.3 THREE methods to overcome armature reaction:

A Air cooling, reducing the speed and manual operation
B Enlarging brushes, shifting windings and using interpoles
C Coal fired, hydro and nuclear
D Brush shifting, using interpoles and compensating windings

1.1.4 Change of flux can be obtained by …

A changing the current in the circuit.
B adding more resistors.
C reducing voltage from the supply point.
D changing the direction of motor rotation.

1.1.5 Purpose of the conservator tank on a transformer:

A Recycles unused water
B Stores extra gas
C Keeps used oil
D Takes up expansion/contraction of oil without allowing it to come in contact with air and take up moisture

1.1.6 THREE methods of cooling transformers:

A Oil cooling, natural cooling and switching it off
B Natural cooling, air cooling and by releasing a gas
C Oil cooling, natural cooling and air cooling
D All of the above

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1.1.7 Slip is defined as follows:

A The difference between rotor speed and synchronous speed.
B The difference between the initial speed and final speed.
C The difference between rotor speed and stator speed.
D The speed at its maximum.

1.1.8 Which motor is superior in efficiency and most extensively used for all types of motors?

A Induction motor
B DC motor
C Universal motor
D All of the above

1.1.9 TWO types of feeders used in a transmission system:

A Square and circle
B Ring and radial
C Circle and ring
D Radial and square

1.1.10 The voltage of a shunt generator may fail to excite because the …

A armature speed is too low.
B field poles have gained residual magnetism.
C field resistance is too low.
D armature speed is too high.

(10 × 1) **[10]**

## QUESTION 2

2.1 A series circuit of 8 ohms and 5 ohms respectively is connected in parallel across a 20 ohm resistor.

Calculate the potential difference across each resistor when this circuit is connected across a battery having an EMF of 24 V and an internal resistance of 0,12 ohms. (8)

2.2 An overhead line of a copper conductor, 16 m in length with a diameter of 1 mm, is capable of carrying 10 A.

Calculate the diameter of an aluminium conductor having the same length which, when connected in parallel with the copper conductor, increases the carrying capacity of the line to 25 A.
Take the resistivity of copper as 0,017 micro-ohm metres and that of aluminium as 0,0289 micro-ohm metres. (8)

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2.3 A coil has 1 200 turns. When a current of 2 A flows through it, it produces a magnetic circuit with a reluctance of 14 000 A/Wb.

Calculate the value of the flux in the circuit. (2)
**[18]**

## QUESTION 3

3.1 A coil of 350 turns has a flux of 4,8 mWb linking with it when carrying a current of 8 A.

Determine the inductance of the coil and the EMF induced in it when this current collapses to zero in 0,02 seconds. (4)

3.2 A battery with an EMF of 36 V and an internal resistance of 0,5 ohms is connected in parallel with a DC generator with an EMF of 48 V and an internal resistance of 0,2 ohms. The combination is used to supply the load with a resistance of 20 ohms.

Calculate the potential difference across the load. (10)

3.3 Name any TWO external characteristics of compound generators. (2)

3.4 Define *Lenz's law.* (2)
**[18]**

## QUESTION 4

4.1 DC machines are named according to the method used to connect the field coils.

Briefly explain this statement. (8)

4.2 Briefly explain how can you overcome the effects of armature reaction (3)

4.3 What is the purpose of a pole shoe in a DC motor? (2)

4.4 Name any FIVE types of capacitors (5)
**[18]**

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## QUESTION 5

5.1 In a certain circuit with two parallel branches the instantaneous branch currents are represented by the following:

$$i_1 = 60\sin(wt + \frac{\pi}{4})$$

$$i_2 = 45\sin(wt - \frac{\pi}{6})$$

Calculate the RMS and average values of the total current. (9)

5.2 A coil with a resistance of 5 ohms and an inductive reactance of 3 ohms is connected in parallel to a series circuit consisting of a resistance of 2 ohms and a capacitive reactance of 7 ohms.

5.2.1 Calculate the magnitude of the supply current if the circuit is connected to a 230 V AC supply. (5)

5.2.2 Calculate the current distributed in each branch of the circuit. (4)
**[18]**

## QUESTION 6

6.1 A 4,4 kVA, 440/120 V, 50 Hz single-phase transformer has 48 turns on the secondary winding.

Calculate the following:

6.1.1 Number of turns on the primary winding

6.1.2 Primary and secondary full-load currents

6.1.3 Maximum value of the core flux

(3 × 2) (6)

6.2 A single-phase motor draws a current of 12 A from a 225 V, 50 Hz supply. The current has a lagging phase angle of 36º.

Calculate the following:

6.2.1 Input power to the motor

6.2.2 Value of the current if the power factor is improved to 0,97 and the input power remains unchanged

(2 × 2) (4)

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6.3 A moving-coil instrument has a resistance of 240 ohms and requires 50 mA to give full deflection.

Calculate the value of the additional component necessary to enable the instrument to measure a current of 25 A. (3)

6.4 Describe the construction of the stator of a split-phase AC motor. (5)

**[18]**

**TOTAL: 100**

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# ELECTROTECHNICS N4

## FORMULA SHEET

Any applicable formula may also be used.

1. Principles of electricity

$$E = V + Ir$$

$$V = IR$$

$$R_{se} = R_1 + R_2 + \ldots R_n$$

$$R_p = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \ldots \frac{1}{R_n}}$$

$$R = \rho \frac{\ell}{a}$$

$$\frac{R_1}{R_2} = \frac{1 + \alpha_o T_1}{1 + \alpha_o T_2}$$

$$R_t = R_\theta \left[1 + \alpha_\theta \left(t - \theta\right)\right]$$

$$P = VI = I^2 R = \frac{V^2}{R}$$

$$\Phi = \frac{mmf}{S} = \frac{IN}{S}$$

$$H = \frac{IN}{\ell}$$

$$F = B\ell I$$

$$E = \frac{\Delta\Phi}{\Delta t} . N$$

$$E = B\ell v$$

$$E = \frac{L\Delta I}{\Delta t}$$

$$L = \frac{\Delta\Phi}{\Delta I} . N$$

$$Q = VC$$

$$Q_{se} = Q_t = Q_1 = Q_2 \ldots = Q_n$$

$$C_{se} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \ldots \frac{1}{C_n}}$$

$$Q_p = Q_1 + Q_2 + \ldots Q_n$$

$$C_p = C_1 + C_2 + \ldots C_n$$

2. Direct-current machines

$$E = \frac{2Z}{c} . \frac{Np}{60} . \Phi$$

$$c = 2a$$

$$E_{gen} = V + I_a R_a$$

$$E_{mot} = V - I_a R_a$$

$$R_{start} = \frac{(V - E)}{I_a} - R_a$$

3. Alternating-current machines

$$E_m = 2\pi BANn$$

$$e = E_m \sin\left(2\pi f . t \times 57{,}3\right)°$$

$$E_{ave} = 0{,}637\ E_m$$

$$E_{rms} = 0{,}707\ E_m$$

$$T = \frac{1}{f}$$

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$$f = \frac{Np}{60}$$

$$\omega = 2\pi f$$

$$Z_L = R + j\omega L$$

$$Z_c = R - j\frac{1}{\omega C}$$

$$pf = \cos\phi = \frac{R}{Z}$$

$$S = VI$$

$$P = V.I\cos\phi = I^2R$$

$$Q = V.I\sin\phi$$

4. Transformers

$$E = 4{,}44\ f\ \Phi_m\ N$$

$$k_t = \frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1}$$

5. Measuring instruments

$$R_{SH} = \frac{i_m\ R_m}{I_{sh}}$$

$$R_{se} = \frac{V}{i_m} - R_m$$

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